Army CRADAs

		Address Warfighting Needs	Reduce Cost	Strengthen the Industrial Base	Promote Basic Research	Assure Quality
A1	Advanced Technology for High Resolution Physics Based Interactive Simulations	●	●		●	●
A2	Blanket CRADA Between Ford, General Motors, Chrysler and the U.S. Army Tank-Automotive Research, Development and Engineering Group				●	
A3	Construction Equipment Performance Optimization			●	●	●
A4	CORE-LOC Concrete Armor Unit			●	●	
A5	Development of Biodegradable Polymers			●	●	
A6	Development of Novel Imaging System for Medical, Non-Destructive Testing & Investigation of Micro-electronic Circuits			●	●	
A7	Evaluation of Electron Cyclotron Resonance Plasma Technology	●		●	●	●
A8	Formulation of a Liposomal Transdermal Vaccine System and Other Novel Pharmaceuticals	●		●	●	●
A9	Full Scale Fabrication & Optimization of Composite Cylinder Processing		●	●	●	
A10	Vaccines for Infectious Desease	●		●		●

Navy CRADAs

		Address Warfighting Needs	Reduce Cost	Strengthen the Industrial Base	Promote Basic Research	Assure Quality
N1	CRADA between The Naval Training System Center and Computer Group of Motorola, Inc.	●	●		●	
N2	Deep-Towed Acoustic/Geophysical System	●			●	
N3	Demonstration of CL-20 Based Explosive Formulations	●		●		
N4	Detection of Contraband and Narcotics by Nuclear Quadrupole Resonance (NQR)/Fast Recovery Time Nuclear Quadrupole Resonance Detection			●	●	
N5	Electric Vehicle/Hybrid Electric Vehicle Battery Chemistry Research & Evaluation				●	
N6	Exploring the Effects of Lipid-Lowering Agents on Complex Cognitive and Performance Tests	●				
N7	New Paint Formulations for Fluorinated Polyurethane Resins		●	●		
N8	Ocean Bottom Profiler (OBP) Joint Project	●		●	●	
N9	Technical Assistance to CIT			●	●	
N10	Use of Spinning Microfilters to Separate Oil from Water for Abatement of Marine Spills				●	

Air Force CRADAs

		Address Warfighting Needs	Reduce Cost	Strengthen the Industrial Base	Promote Basic Research	Assure Quality
AF1	Automated Software for Composite Material Analysis			●	●	
AF2	Covert Adjustable Laser Illumination CRADA	●		●		●
AF3	Hazardous Materials Management System		●	●		
AF4	Helmet Mounted Display Fitness of Use	●			●	
AF5	Ogden Air Logistics Center X-Ray/Computed Topography Sections			●	●	
AF6	Strategic Avionics Battle Management Evaluation and Research (SABER)	●	●			
AF7	Test and Evaluation of Imaging System	●		●		
AF8	USAF CRDA Between Weber State University and the Science and Engineering Laboratory				●	
AF9	Warhead Arena Test				●	
AF10	Whole Spacecraft Isolation System for Taurus/GEOSAT	●	●		●	

V. Benefits of CRADAs to the DoD S&T Program:

Reflecting the DoD S&T Guiding Management Principles

Technology superiority in military capabilities is the main objective of DoD's S&T program. Lower budgets are driving an increased emphasis on affordability, longer lived weapon systems, and insertion of new technology as well as developing dual use technologies where appropriate. Leveraging the scientific community to take advantage of progressive technologies for military applications is increasingly occurring.[26]

DoD has developed five management principles to guide in the development of the S&T programs of the Military Departments and Defense Agencies. These management principles, or elements, are designed to place the best mix of capabilities possible into the hands of the operational forces by leveraging the best resources in the DoD and the nation.[26]

Guiding Management Principles of the DoD S&T Program

- Transition Technology to Address Warfighting Needs
- Reduce Cost
- Strengthen the Industrial Base
- Promote Basic Research
- Assure Quality

Since CRADAs must support specific R&D efforts that are related to and consistent with the DoD laboratory's mission, it is reasonable to assume that if the CRADAs evaluated in this study reflect the DoD S&T guiding management principles, then they have added value to the DoD S&T program as a whole. In fact, many of the CRADAs evaluated met more than one of these management principles. Although there were many examples from this study from which to chose, a few examples are given here to illustrate how CRADAs are adding value to the elements of the DoD S&T effort.

Transition Technology to Address Warfighting Needs

Evaluation of Electron Cyclotron Resonance Plasma Technology (A7)

Work in the area of focal plane arrays (FPAs) is one of the current DoD long-term investment initiatives in technology maturation. The Army is very interested in focal plane arrays for use as sensors in tanks, helicopters and missiles. These sensors act as an artificial retina and detect thermal radiation. They are used in heat seeking missiles where they can hone in on a target that is warmer than its surroundings and in night vision navigation applications. Army requirements for higher standoff distances and target recognition capability have led to concepts for a next generation of arrays whose pixels need to be considerably smaller and more closely spaced than those on currently available arrays.

The current industrial baseline process for producing focal plane arrays with mercury cadmium telluride has been to form mesas and trenches in the layers by dipping them into a liquid chemical etchant. All second generation focal plane arrays are manufactured with this technology. In a CRADA between the U.S. Army Communications and Electronics Research, Development and Engineering Center, Night Vision and Electronics Sensors Directorate (NVESD) and Texas Instruments (TI), the suitability of a new vapor phase etching process, Electron Cyclotron etching (ECR), as a potential replacement for liquid phase etching was explored.

After one year the etching process looks promising. A few milestones towards developing the next generation FPA via vapor phase etching have been achieved. The vapor phase etching process produced a FPA 128 pixels by 128 pixels with each pixel being 24 microns by 24 microns. Given that the largest FPA made by existing methods is 1024 pixels by 1024 pixels, more milestones still lie ahead. TI has now purchased a plasma reactor identical to the one used

at NVESD in order to continue the research effort and hope to eventually integrate this technology into their production line.

CRADA Between The Naval Training Systems Center and the Computer Group of Motorola, Inc. (N1)

The interfacing of simulators is highly desirable in the synthetic battlefield. The Distributed Interactive Simulation (DIS) interoperability standard provides a protocol for formatting messages that enable simulators to communicate with each other. The Naval Air Warfare Center, Training Systems Division and Motorola teamed in a CRADA to gain experience with the new DIS interoperability standard through jointly developing software to support networking of simulators using distributed interactive simulation.

Three software products/tools (Middle Man, Aladdin, and Daemon) resulted from the work performed under this CRADA . The Aladdin is a powerful DIS stealth application which enables the warfighter to view the synthetic battlefield from different perspectives including a "god's eye view." This software has been used in several other programs including Army and Air Force programs. Since Motorola does not hold intellectual property rights, these products are available to government agencies and their contractors free of charge.

Ocean Bottom Profiler (OBP) Joint Project (N8)

The Naval Undersea Warfare Center, Division Newport, (NUWCDIVNPT) and Precision Signal, Inc., (PSI) collaborated under a CRADA to develop state-of-the-art equipment known as the Ocean Bottom Profiler, OBP. The OBP was expected to be capable of producing three-dimensional images of the sub-bottom sea floor mapping the ocean floor in deep and shallow water as well as assisting in the study of the geomorphology of the bottom by returning information on sediment layers.

With this new vehicle, buried objects in the sea floor can be located and improved data for remote classification of the sea floor can be obtained. PSI and NUWCDIVNPT have worked to develop an array of receivers for electronic near-field beamforming objects in the sediment. Using previously developed acoustic transducer and acoustic baffle technology, a large, low frequency vehicle was constructed at PSI, and test data proved the feasibility of acoustic detection of buried objects in the sea floor. Acoustic sediment layers can now be measured in the ocean floor down to a level of 64 meters with a 9 cm resolution.

The results of these efforts significantly contributed to the design of the AN/WSQ-9 Sonar System, a NUWCDIVNPT initiative that will soon provide significant new warfighting capabilities in mine detection to the U.S. Submarine Fleet. The first installation of this capability into a U.S. submarine is planned for FY99.

Reduce Cost

New Paint Formulations for Fluorinated Polyurethane Resins (N7)

The Navy was using a fluorinated polyurethane paint as the top coat for their Navy Facilities Engineering Command, Navy Facilities Guide Specification 09872, four-coat paint system (wash primer coat, zinc-rich urethane coat, urethane manufacturing coat and fluorinated top coat) for coating the inside of petroleum storage tanks. 21st Century Inc. licensed the technology for the fluorinated polyurethane from the Navy and combined it with technology from other patents and developed a three-coat variant paint system (two epoxy coats and a highly fluorinated top coat) called WC5, Navy Facilities Guide Specification 09970.

21st Century tested this new paint system at the Naval Research Laboratory paint shop facility. The top coat on the WC5 paint system is a highly fluorinated coating that is very stable, flexible, chip resistant, UV resistant, and hydrophobic. As an example of the cost savings, coating a tank that is 40 feet in diameter by 35 feet in height with the old system would cost approximately $29,714.00 compared to the same tank coated with the WC5 system which would cost approximately $12,952.00. The savings just in the application costs in going from a four-coat process to a three-coat process is $2,827.44. WC5 is now being used on Navy petroleum storage tanks as well as those of the Army Corps of Engineers.

Hazardous Materials Management System (AF3)

The U.S. Air Force Research Laboratory, Materials and Manufacturing Directorate (AFRL/ML) uses more than 10,000 different chemicals in over 40,000 containers in its 15 facilities. This level of activity and complexity necessitates a very aggressive pollution prevention program to assure that health and safety are a top priority and that environmental issues are correctly managed.

The AFRL/ML, under a CRADA with Modern Technologies Corporation, developed a computerized system using bar code technology to coordinate the tracking and control of hazardous materials including levels, location changes, usage rates, and other critical data. The system, LINDEN™ Environmental Management System (LINDEN™), enables effective centralized hazardous materials management, waste minimization and pollution prevention efforts. It also reduces materials costs and prevents materials shortages through more effective control and retrieval. Using system data, the storage of hazardous chemicals is consolidated, helping to eliminate duplicate and excess stock.

At the Directorate, over 40,000 hazardous materials and waste containers were tracked throughout their complete use life, resulting in purging of over 10,000 hazardous material containers no longer needed by researchers. More than 400 containers of unknown materials were identified, classified and eliminated. In some cases, the effort permitted the identification of replacement chemicals that are less harmful to the environment. The system was extended to include laboratory facilities across Wright-Patterson AFB and has been selected for implementation at other government installations.

The value in using the LINDEN™ system to reliably manage a hazardous materials program at the AFRL/ML is conservatively estimated to be $10K in terms of equivalent contracting costs. The LINDEN™ system also saves labor hours that would typically be spent on documentation and tracking.

Strengthen the Industrial Base

Construction Equipment Performance Optimization (A3)

Current tire models do not consider the interaction of the tire with deformable media such as soil or snow, focusing only on interactions with pavements. An ongoing CRADA between the Army Cold Regions Research and Engineering Laboratory and Caterpillar, Inc. and Goodyear Tire and Rubber Co. is looking to develop a numerical model simulating the interaction between tires and deformable surfaces such as thawing and soft soils. This project will integrate the experimental and numerical simulation of tractive loading on deformable terrain with numerical models of tire deformation resulting in a three dimensional finite element simulation of tire-terrain interaction. The expected result of this collaboration is a design tool with the capability to design tires that perform more efficiently on unpaved roads, off-road, and in all-season conditions including snow and thawing soils. In addition, the technology will be used to explore the effects of tire and terrain variables on vehicle performance and terrain damage.

The technology being developed through this CRADA is truly a dual-use technology in that this tool can be applied to the development of commercial as well as military products. In the commercial sector, the use of this tool is expected to greatly improve the efficiency of off-road, mud and snow, and heavy vehicle tires as well as increase construction site productivity by improving vehicle traction resulting in decreased cycle time, fuel costs, tire wear, and time lost due to immobilization, surface damage and repair or reclamation costs. DoD will use this tool to improve tire design and specification, improve performance prediction for off-road vehicles, and provide the capability to predict rutting of and soil damage to unsurfaced roads and to Army training grounds.

Ocean Bottom Profiler (OBP) Joint Project (N8)

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With this new vehicle, buried objects in the sea floor can be located and improved data for remote classification of the sea floor can be obtained. PSI and NUWCDIVNPT have worked to develop an array of receivers for electronic near-field beamforming objects in the sediment. Using previously developed acoustic transducer and acoustic baffle technology, a large, low frequency vehicle was constructed at PSI, and test data proved the feasibility of acoustic detection of buried objects in the sea floor.

The Ocean Bottom Profiler program produced the 512 Sonar Vehicle which was first tested and modified at the NUWC laboratory for use in Narragansett Bay. As a result of this testing and calibration, acoustic transducers, receiver arrays, and acoustic baffle materials were incorporated into the 512 design that have made the 512 profiler superior in performance to all bottom profiling vehicles worldwide. Acoustic sediment layers can now be measured in the ocean floor down to a level of 64 meters with a 9 cm resolution.

The 512 Sonar Vehicle is a dual-use development used by many universities, commercial and military users to obtain quantitative and qualitative information on sea floor sediments. The 512 Sonar Vehicle is now manufactured and marketed worldwide by Edge Tech, Inc. under an agreement with PSI. Edge Tech is estimated to be an $8M company with 35 employees. The 512 Sonar Vehicle accounts for about 25% of their business.

Detection of Contraband Narcotics by Nuclear Quadrupole Resonance (NQR) (Follow-on CRADA: Fast Recovery Time Nuclear Quadrupole Resonance Detection) (N4)

The Navy has had a general interest in advanced detection capabilities for narcotics for use with its own forces. In the past this work has been sponsored by DoD and the Defense Advanced Research Projects Agency's (DARPA's) Counterdrug Program.

The objective of the initial CRADA between the Naval Research Laboratory and Quantum Magnetics was to look at using quadrupole resonance to detect heroin hydrochloride and cocaine hydrochloride. The signal, however, was very difficult to see. It was determined that the objectives of this CRADA were too aggressive. Therefore, a second CRADA was initiated to focus on specific advanced circuitry, a rapid recovery receiver, to detect narcotics and explosives. The advanced circuitry studied in this collaboration will be incorporated into a larger commercial system which will result in a better scanner for heroin and cocaine detection than what is currently available.

Automated Software for Composite Material Analysis (AF1)

Modern composite materials are unique in the directional dependence of their strength, stiffness and thermal expansion characteristics and are not amenable to the use of design and analysis procedures employed for conventional isotropic structural materials. The use of modern composites has been steadily increasing and to make the best use of their capabilities, it is extremely important that sophisticated and reliable analysis procedures be established. A number of computer programs and advanced theories for predicting the response characteristics of advanced composite structural materials have been developed and their use continues to grow.

Under a CRADA, Adtech Systems Research and the AFRL/ME were able to develop a fully documented commercial software package, Automated Software for Composite Analysis (ASCA). This software package consists of solution procedures for the efficient analysis of composite materials that are leading to new and innovative avenues for developing optimum designs and establishing new goals.

The number of organizations actively pursuing the development of the use of composite materials is growing. The software package developed under this CRADA is serving the needs of both the Government and private industry. Customers of the package include the aircraft industry (such as Boeing, Lockheed, and United Technologies), composite materials manufacturers, the automobile industry, academia, research organizations, and spacecraft manufacturers.

Promote Basic Research

Formulation of a Liposomal Transdermal Vaccine System and Other Novel Pharmaceuticals (A8)

The Medical Technology and Practice Patterns Institute, Inc. (MTPPI) and Walter Reed Army Institute of Research teamed together through a CRADA to develop vaccine adjunct technology to devise an effective, safe and easily administered delivery mechanism for vaccination. MTPPI is dedicated to the development and transfer of medical technology through the Vision for World Health Project. MTPPI has identified the need to introduce an alternative vaccine delivery system to reduce the cost and increase the accessibility of vaccination, especially in Third World settings. A liposomal transdermal vaccine system would allow immunization without the need for sterile needles, syringes, and trained personnel, as well as would avoid the complications associated with puncturing the skin.

As a result of this CRADA, a new means of transdermal vaccine delivery was discovered and has advanced the process of bringing needle-free vaccine technology to market. In an article published in Nature magazine,[29] cholera toxin (CT), used to enhance the immune system, was applied to the surface of the skin. When applied, it stimulated an immune response to vaccine components such as diphtheria or tetanus toxoids. This experiment concluded that immunization can be achieved by the simple application of a mixture of CT and vaccine components without penetration or disruption of the skin.

The preclinical research conducted under this CRADA has led to the first clinical trial for a vaccine of particular interest to the Army, E. coli endotoxin technology, for soldiers' diarrhea. The vaccine will be used in field operations. This first FDA-approved Phase I clinical trial has been completed. Phase II and Phase III must now be competed prior to filing a new drug application (NDA), followed by licensing by the FDA. It is anticipated that the Phase II trial will be completed in FY99. For most products, it typically takes 5 to 10 years and an investment of $50 million to $200 million to complete all testing phases, including NDA filing, for licensing by the FDA. For the vaccine being investigated under this CRADA, research has been ongoing for less than two years.

This type of vaccine delivery system also has direct commercial applications to many vaccines such as those being developed for HIV, etc. In addition, to vaccines for human use, it is currently being considered for use on pets.

Two patent applications have been filed on inventions created under this CRADA and a third is in preparation. A major licensing agreement has been executed between WRAIR and MTPPI and sublicensing arrangements with commercial developers and end-users of the technology have begun. This CRADA is on-going with an expiration date of December 31, 2005.

Use of Spinning Microfilters to Separate Oil from Water for Abatement of Marine Oil Spills (N10)

The Marine Spill Response Corporation (MSRC) was a consortium of oil companies, funded by Superfund, whose purpose was to investigate technologies for handling oil spills at sea. A CRADA was developed between the U.S. Naval Surface Warfare Center (NSWC), Carderock Division and MSRC to demonstrate the separation of seawater from oil spill fluids in a wide range of viscosities using non-clogging spinning microfilter oil/water separator technology.

A new concept of separating the oil/water mixture and later disposing of the separated components was explored. A working prototype was developed to prove the concept. The new concept explored under this CRADA has led to the development of a patented process to quickly and effectively separate oil from water with the use of a spinning micro-filter system. NSWC believes that this process may have additional commercial applications.

Ocean Bottom Profiler (OBP) Joint Project (N8)

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In the course of developing the OBP, valuable research was accomplished in the disciplines of acoustics and signal processing, as well as in electronic design, to achieve a multi-channel sub-bottom imaging device which can be incorporated into many applications. As a result of this research, acoustic sediment layers can now be measured in the ocean floor down to a level of 64 meters with a 9 cm resolution.

USAF Cooperative Research and Development Agreement Between Weber State University and the Science and Engineering Laboratory (AF8)

Weber State University (WSU) is a Center for Excellence for Chemical and Materials Analysis which attracts researchers from local private sector businesses. To support various research projects, a CRADA between the Ogden Air Logistics Center, Technology and Industry Support Directorate (OO-ALC/TI) and WSU was developed to provide WSU faculty and staff access to the Air Force Laboratory test instrumentation and/or its science and engineering personnel. Analytical costs associated with these research projects are paid by participating businesses to WSU. In turn, WSU pays the Air Force its normal shop rate for costs incurred in item testing, equipment usage, training, and consultative work for these research projects.

This CRADA established a cooperative association between university academia and Air Force scientists. DoD expertise as well as facilities are shared with the university and the community thus fostering and promoting research between the two partners. The WSU lab personnel and collegiate staff are able to access unique laboratory testing and particular scientific equipment, as well as become involved in consultative evaluations with experienced DoD scientific and engineering personnel. The exchange of test data, consultative sessions and professional personnel interaction has exposed WSU's chemical/materials staff and student population to realistic industrial laboratory education. This cooperative agreement has provided the OO-ALC/TI laboratory personnel with access to collegiate industrial technology, current research, fellowship with professional individuals, and associations with graduate students that may become future DoD scientists, engineers and technicians.

Although this CRADA focuses on promoting basic research, the various research projects undertaken in this collaboration may address other DoD management principles such as warfighting needs, strengthening the industrial base, and reducing cost.

Assure Quality

Advanced Technology for High Resolution Physics Based Interactive Simulation (A1)

Silicon Graphics, Inc. (SGI) has negotiated CRADAs with CECOM, Night Vision and Electronics Directorate and the U.S. Army Research Laboratory in the area of simulation technology. The NVESD team contributes expertise in sensor simulation, building optimized databases, and immersion techniques. NVESD uses off-the-shelf dedicated equipment to implement sensor simulation and three dimensional noise for special effects. NVESD interest was in pursuing the development of technology to simulate additional sensors and optimize databases associated with them. ARL's interest was in developing a simulation system to provide the appropriate combination of physical models to simulate the effects and interaction of the synthetic environment and the end-user.

The purpose of the agreement with NVESD was to develop an enhanced operational and modeling and simulation capability for individual combatants across three domains of Advanced Concepts and Requirements (ACR), Research, Development and Acquisition (RDA), and Training, Exercises, and Military Operations (TEMO). It was NVESD's objective to support military needs and objectives while fostering development of novel software/hardware for optimized terrain and

sensors with substantial commercial potential to contribute to the economic and military success of the U.S..

The NVESD partnered with SGI because of SGI's reputation as the leading manufacturer of high performance visual and enterprise computing systems. SGI was to provide graphics and computer technology to support the development of high fidelity, interactive synthetic environments for training and operational use.

Covert Adjustable Laser Illuminator CRADA (AF2)

Many Federal and local government entities have a need to positively identify ships and aircraft that are detected by electro-optical sensor systems. This identification must be quick, accurate, and admissible in a court of law. A CRADA between the U.S. Air Force Research Laboratory, Directed Energy Directorate, (AFRL/DE), and FLIR Systems, Inc. (FSI) was established to explore the feasibility, applicability, safety and utility of a fiber coupled diode laser to illuminate an image from a gimbaled assembly. An eye-safety analysis, a positive phenomenology study, and successful ground and airborne field tests were performed.

The integrated system developed in this CRADA enhances FLIR's gimbaled IR sensor system by allowing an area of terrain to be illuminated by a laser and viewed on a screen. The range for this system is approximately 1 km. When used in search and rescue operations, the viewing range can be 5 to 10 km.

The development of an integrated system was derived from the core competencies of both Air Force Research Laboratory and FLIR Systems Inc. While the Air Force's expertise is in the development of fiber coupled diode lasers, FSI's expertise lies in that it is a commercial vendor for products that employ a stabilized Gimbal sensor system with thermal capabilities. This work resulted in transitioning the technology to FSI where they are actively pursuing incorporating the technology into a commercial system. Potential buyers include the U.S. Border Patrol, U.S. Coast Guard, Canadian Government, and German Navy.